EDIBLE SOYBEAN OIL[1]

Herbert J. Dutton
Northern Regional Research Laboratory[2]
Peoria, Illinois

In any discussion of the future of edible soybean oil, it is necessary that the significance of competition by other edible oils be given serious attention. For instance, in the past and also in recent months soybean oil has been able to do no better than come within 1 to 9 cents a pound of cottonseed oil in the market. This situation occurs notwithstanding that in chemical composition and physical properties the two oils do not differ greatly; also that in many of its properties edible soybean oil is equal or superior to edible cottonseed oil. After the whole story is told, one comes to the inescapable conclusion that the cause of this price differential between soybean and cottonseed oils is the peculiar flavor instability of soybean oil. While cottonseed grows rancid on ageing and corn oil becomes stale, soybean oil is said to "revert." By "reversion" is meant the objectionable painty-grassy flavor peculair to aged soybean oil. We are not in a position to say whether a rancid cottonseed or a stale corn oil is better or worse than a reverted soybean oil. In fact we are not the final judges. The American housewife already appears to have decided in favor of corn and cottonseed oils and her preference costs Midwest soybean growers 10 to 90 million dollars a year, based on the 1 to 9 cents per pound differential. Therefore, as research workers, we are endeavoring to find out what can be done to improve the flavor qualities of soybean oil. If we do not, the wartime expansion in soybean production, processing capacity, and edible soybean oil products is expected to recede before the competition of the more stable oils.

I think you will appreciate better the extreme difficulty presented to research workers in this field of odors and flavors when I tell you that odoriferous or flavored materials can be detected by our sense of taste and smell in concentrations of a few parts per billion. There are few chemical or physical tests which can rival the sensitivity of the sense of taste or smell, and at present there are none which can measure the off-flavor of soybean oil. Until the time when an objective physical or chemical test is discovered, we will be forced to rely upon the fallible human sense of taste and smell. Literally the proof of the soybean oil pudding is in the tasting.

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2/ One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

We have gone to great lengths to put our taste testing, or organoleptic evaluation, on a sound basis. Let me interpolate here that we are entirely debunked of the idea of the "expert" whose opinions have been law in the liquor and tea industries. Our objective tests have shown up many self-styled experts as very unreliable performers. Therefore, we rely only on the evaluations of not less than 10 judges whose sensitivity and consistency have been rigorously established. The procedure of our taste-panel tests follows this order: A pair of samples is presented each taster in a "blind" test; samples are held at the same temperature by a heated aluminum block. Tasting is performed in a room that is quiet and free from distracting influences. Flavor evaluations are recorded, scores are averaged, and the significance of the results analyzed by statistical methods. I am happy to report that when these elaborate precautions are taken, reliable and reproducible taste data can be obtained. We hail this development, humble as it may be, as a milestone in our research progress because without a reliable method of evaluation it is impossible to determine when improvements in processing treatments have been made.

Research work at the Northern Laboratory on the flavor problem of soybean oil follows two general lines of attack. The first consists of fundamental investigations to isolate and identify the flavor substances which develop in soybean oil and, in addition, to identify the compounds in soybean oil from which these flavored substances arise. Once this information is acquired we should be in a favorable position to suggest remedial measures and corrective methods of processing. This new mode of attack is now being implemented under the authorization of the Research and Marketing Act.

The second line of attack, which has been under way for 2 years is a more empirical approach to the problem but already has given concrete evidence of its value. It is based on the observation that present soybean oil refining methods, "like Topsy," just grew, and on the idea that new methods less drastic than those used now may yield flavor-stable soybean oils. After all, name a product other than oil, if you can, that may be heated in the flake during tempering, be expelled at high temperatures and pressure, be refined with steam, hot alkali, and bleaching earth, be deodorized by holding it at 450° F. with steam passing through it continuously for 8 hours--which still will come out an edible product after all this abuse.

After investigating refining procedures in a number of commercial processing plants and checking them against results obtained at this Laboratory, we can now put our finger on several steps in which loss of stability occurs. For example, in commercial processing the final traces of solvent are removed from the oil in tall stripping columns by passing superheated steam counter-currently through the oil. We have found the oil to be damaged in the columns of certain plants where presumably excessive heating occurred. Bleaching earths are used in refining to absorb the pigments and thus lighten the color of oils. Also, they remove the protective antioxidants and thus lower flavor stability.

We have found that oils deodorized in laboratory glass apparatus are more stable than portions of the same oil deodorized in commercial metal equipment. Recently the equipment factor has been brought home to us very convincingly. We had a small stainless steel (unpolished) deodorizer constructed for our laboratory use but we have yet to prepare an acceptable oil with it. Much can be done to improve the stability of soybean oil if first we learn in which refining step the oil is being damaged.

Definite progress has been made as a result of this empirical approach. We have found that the shelf life of soybean salad oil can be extended from the usual 1 month to as much as 4 months if, during deodorization, the oil is treated with any of a number of compounds, such as citric acid, sorbitol, mannitol, tartaric acid, and tricarballylic acid. Moreover, we have found how these compounds function. Metals such as iron and copper are natural constituents in soybean oil. Additional metals are picked up from the pipes, valves, and kettles as the oil passes through the refining process. Now, as little as 0.3 p.p.m. of copper will ruin soybean oil. It does so because copper is a strong oxidation catalyst. It speeds up or catalyzes the reaction of atmospheric oxygen w ith the oil and causes the oxidation, the reversion, and the rancidification of the oil. Citric acid, sorbitol, and similar compounds improve the oil because they react with the metals, take them "out of circulation," and destroy their catalytic effect on oxidation of the oil,— they "complex" metals as we say, and thus reduce the rate of oxidation of the oils. It is true that by these treatments we have not solved the flavor problem of soybean oil. We have not eliminated the undesirable flavors from it; nevertheless, we have been able to delay the appearance of "reversion" to such an extent that several large refiners of soybean oil have now added these treatments in their commercial production. After all, if the onset of deterioration can be sufficiently delayed, our main objective shall have been accomplished.

We are aware, however, that a more permanent solution of the flavor problem of soybean oil is required. This awaits the acquisition of more fundamental knowledge concerning the chemical nature of the flavor material.

There is no lack of theories and hypotheses as to the cause of the peculiar flavor instability of soybean oil; there are nearly as many theories as there are research men. But let me add in the same breath that there is a dearth of evidence to support any one of the theories. Among them the oldest and perhaps still as useful as any is the one centering around linolenic acid. Linolenic acid is one of the component fat acids of soybean oil. You will not find it in corn, cotton, peanut, and other flavor-stable oils. But it is present in soybean and linseed oils, both of which are plagued with flavor reversion. On this bit of circumstantial evidence, the coincident occurrence of linolenic acid and flavor reversion, hangs this flavor reversion theory.

One approach to the problem of determining the compound responsible for the undesirable flavor is to isolate the various constituents of soybean oil suspected of being flavor instable and to add these constituents to a flavor

stable oil such as corn or cottonseed oil. When the precursor of the "reversion" flavor is isolated and is added to a flavor stable oil, this oil should then resemble soybean oil in flavor characteristics upon storage.

By this and other methods of research, we hope to learn the true nature of flavor deterioration and to be able to recommend preventative measures. On the basis of our success in the discovery of metal scavengers, we have "reason for the faith that" by a scientific approach to the problem and continued research, the flavor stability of soybean oil can be improved to equal eventually that of competing oils.